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presence of the committee take an observation and compute the result. The time devoted to each subject must vary according to the individual capacity of the student and other circumstances, but before presenting himself for examination he is kept at each subject until he understands it and has done the practical work required.

Courses in geology, botany, zoology, anthropological measurements, photography and meteorology, also give explorers careful training in these phases of field work. All lessons are given at sixty cents an hour.

The intending traveler may thus prepare himself thoroughly to profit by any opportunities he may meet at a very moderate cost. Many eminent explorers have been pupils of Mr. Reeves, among them, Mr. Shackleton, Mr. Boyd Alexander, famous for his journey from the Niger to the Nile, Mr. Douglas Carruthers, well known for his work in Asia and Arabia, and Major Fawcett, who has been exploring the region around the Heath River in South America. This effort by the Royal Geographical Society to help explorers has been most successful, judged by its results, and might with advantage be imitated by the geographical societies of other countries.

THE SWEDISH SOUTH POLAR EXPEDITION*

A REVIEW

This initial number of the scientific reports of the Swedish Antarctic Expedition, though it appears subsequently to the issue of a considerable number of parts devoted to specialized topics, furnishes the commander's general summary of geographical discoveries, combined with a report upon the morphology, glaciology, and regional geology. These subjects, though covered with some fullness, are yet regarded as summaries which are to be followed by more detailed studies.

Some knowledge of the wealth of scientific results which the Swedish expedition has furnished has already been acquired from the published popular narrative of the expedition (already in several languages), from Nordenskiöld's "Die Polarwelt," as well as from numerous papers which the commander has published in scientific journals.

After a condensed narrative of the expedition, there follows a critical résumé of earlier expeditions into the same region. The "Morrell Land" which was entered upon the map of the late Scotch Antarctic Expedition as lying to the eastward of King Oscar Coast, Nordenskiöld shows to have no existence, and severely scores Captain Bruce for rehabilitating this supposed land mass without observations to prove its existence. He also lends the weight of his authority for the use of the terms East Antarctica and West Antarctica, the latter a substitute for the veritable babel of names originally applied to and still retained for sections only of the coast and intended as monuments to earlier explorers. The recent discovery by Amundsen that King Edward Land and Victoria Land are connected, in no way destroys the value of this distinction.

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* Die Schwedische Südpolar-Expedition und ihre geographische Tätigkeit. Von Otto Nordenskjöld. *Wissensch. Ergebnisse der Schwed. Südpolar-Exped. 1901-1903,* Bd. 1, Lief. 1, 232 pp. Maps, ills. Lithogr. Inst. des Generalstabs, Stockholm, 1911. Mks. 24. 11 x 8½.

Rocks of various intrusive varieties are described which, like those already studied by the Charcot and the earlier "Belgica" expeditions, exhibit close correspondence in characters with the peculiar Andean intrusives which occur along the American cordillera from Alaska to Patagonia. In addition to these intrusive rocks, the corresponding volcanic varieties, and particularly the Andesites, are represented and are closely related to those which have been collected in Patagonia. Thus valuable confirmatory evidence is supplied for the connection of the mountain arc of the South Sandwich Islands with the Andean system.

The portion of West Antarctica which was more carefully studied by the expedition, lies about Admiralty Strait and includes the James Ross, Snow Hill and Seymour Islands. Of these, the first mentioned is much the largest and consists of basalt and basaltic tuff, whereas the other islands of the group are of flat lying sediments of Cretaceous and Tertiary age which form the basement series of the entire district. The uppermost member is a hard, dense schist metamorphosed through contact with the basalt, and beneath this schist are found in turn glauconitic sandstone, shale, hard clay-stone and sandy shale.

Perhaps the most novel and interesting features of the report have to do with the glaciers. The two larger islands are almost buried under white domes of snow and ice (*Eiskuppel*), the irregularities of the rock basement making themselves apparent, however, in marked protuberances of the white surface, though the lithosphere is found exposed only upon the margins. Of Snow Hill Island, upon which the winter quarters were located, all rock was covered save only a small area at the north-east end, and the ice dome extended out at all other margins as an ice foot resting upon the sea. Something approaching this condition appears to belong to the islands of Franz Josef Land within the Arctic region.

Throughout a period of eighteen months measurements were made both upon the rate of accumulation of snow and upon the lateral movement of surface portions of the Snow Hill ice dome at localities about a kilometer back from its margin. Only one of the bamboo rods used for these tests betrayed any appreciable lateral movement during this entire period, and its migration could have been at most but a small fraction of an inch per day. Though the methods used lacked precision, the results may still be interpreted to show that the motion of this ice cap even near its margin is excessively sluggish.

The normal section of the materials composing the glacier of Snow Hill Island possesses considerable interest. Beginning at the top it consists of: (*a*) a thin cover of snow modelled in snow drifts and fixed sastrugi; (*b*) a crust of firmer ice often possessing a coarse, granular cell structure and so thin that the foot sinks through it; (*c*) a layer of variable thickness consisting of snow of the preceding summer and a beautiful alternation of thin laminæ of partially consolidated ice and of névé snow; (*d*) a layer of stratified névé ice varying from nothing to a thickness of twenty meters; and (*e*) the true glacier ice. The borders of the ice dome which covers James Ross Island are curiously indented by broad cirque-like amphitheatres which expose the steep rock wall beneath the even surface of the ice dome above. These amphitheatral depressions of the marginal portion of the great ice dome are occupied by glaciers of a new type, the nourishment of which offers interesting problems. In each case one or more narrow ice cascades descend over the wall of the amphitheatre from the glacier dome above. The largest of these glaciers and the one chosen as the type is the Hobbs Glacier, ten km. long, with a wall at the front which is three km. broad. The steep to vertical rock wall everywhere rises above the glacier to the ice dome above except where two narrow cascades connect the higher and lower ice masses. Essentially the same characters are possessed by the Gourdon and Rabot glaciers. Concerning the nourishment of these interesting ice streams, Nordenskiöld says, "they represent a peculiar type of mountain glacier, and above all, a type of very large deep-lying cirque glacier which is nourished both by snow avalanches and ice cascades and by local precipitation."

Nordenskiöld's monograph furnishes the first full account of the shelf ice of the King Oscar coast, and this, he believes, was formed through the loading of sea ice by surface snow precipitated in successive seasons. Studies carried out upon Larsen Bay indicate that there shelf ice of this character is now in process of formation. The main platform of shelf ice, described as the "lower terrace," embraces about 10,000 square miles and has a gentle slope outward from the land and from the higher terrace to the southward, in which respect it differs notably from the shelf ice of the Great Ross Barrier between King Edward and Victoria Lands. Thus to the northward it rises about fifteen meters above sea level, in its central portions it has an estimated elevation of thirty meters, and near the land to the southwest, forty to forty-five meters. Only in the neighborhood of the land does its surface vary from a level plain, but upon this margin it presents notable undulations and often local fissures. From examination of the latter it was learned that the shelf ice there consists of a very regular alternation of blue and white ice layers. To the southward toward the higher ice mass of Jason Land it consists of beautifully bedded layers of névé ice. Nordenskiöld believes the shelf ice to be either floating or resting upon the shallow sea bottom, the outward slope of the upper surface greatly favoring, as it seems to the reviewer, the latter view. Toward the northeast, volcanic islands—the Seal Nunataks—are included. That the shelf ice is in motion outward from the land, Nordenskiöld believes to be proven both by the absence of the compression zone and the presence of numerous fissures along the land margin. Above the shelf ice to the southward is a higher mass of ice—the "higher terrace"—which rises in steps from the shelf ice and has at the base of each step a system of deep and wide fissures. The lowest of these steps rises a distance of some thirty to forty meters from the shelf ice, which is here some fifty meters above the sea. After three successive steps of this sort, the surface of the ice becomes flatter and the succeeding steps less prominent; but there is still an alternation of hills with flat depressions. Above the Borchgrevink Nunatak, at an elevation of more than 250 meters, the surface of the ice plateau is quite level as far as the eye can reach. This interesting body of ice Nordenskiöld has now named the Philippi Glacier in honor of the late Professor Philippi, and while he is unwilling to make a very definite assertion concerning its origin, he appears to favor the view that it is a continental glacier, and it certainly bears a close resemblance to the continental glacier of Antarctica in Kaiser Wilhelm Land.

In view of the manner of origin which Nordenskiöld has assumed for the shelf ice, and we believe that his arguments are well supported, he has included shelf ice as a distinct glacial type in the system which he adopts to apply especially to Antarctic conditions. In it he has recognized clearly the distinction between mountain and continental glaciers:

I. Glaciers of the coast zone and shelf. (*a*) Ice foot glaciers; (*b*) shelf ice.

II. Continental glaciers. (*c*) Inland ice.

III. Transitional forms between continental and mountain glaciers. (*d*) Highland glaciers (Norwegian type); (*e*) true Piedmont glaciers; (*f*) Spitzbergen type.

IV. Mountain glaciers.

Under the head of mountain glaciers, Antarctica furnishes a number of rather special types, among which the Spitzbergen variety, which is almost an ice cap, is particularly common.

Among the many other interesting problems which are treated in this report, perhaps the most novel and instructive are included under the heading "Frost weathering, earth flow, and striped ground." Attention is now being strongly focussed upon this newly exploited series of geological properties having a special application in those high latitude districts where the ground is only partially snow-covered during the warmer months of the year. The pictures which illustrate this section are the finest that have yet been published of "polygonal ground" and "striped ground." Nordenskiöld has shown that these two contrasting types of ground are connected through gradational varieties and are characteristic respectively of flat and sloping surfaces. His studies have further proven that these striking phenomena are notably superficial in character, being restricted to a layer of soil at most a half meter in thickness, which, when saturated with thaw water, slides over the permanently frozen underlying materials. In common with other recent workers upon the subject, he has suggested that regelation may play an important rôle in the migration of the soil and in the differential movements of the rock fragments. Experiments carried out at Snow Hill show that the motions to which these curious structures are due are too slow to be perceived during the period that the station was occupied.

Of the important section of the monograph which deals with the development of surface features upon the land, there remains space only to refer to the striking analogy between these cold humid deserts and the hot and dry areas of lower latitudes. To replace the natural sand blast of the better known deserts which etches out hollows over the softer rock materials, there is here a blast of tuff fragments driven by the Antarctic blizzards which leaves similarly hollowed surfaces on exposed rock masses wherever softer materials are found associated with harder ones. The most that can be done in a review of this nature is to touch a few of the high points in this notable monograph.

WILLIAM H. HOBBS.